DATA ASSIMILATION AND COUPLING THE GLOBAL NRL MODEL WITH THE REGIONAL PRINCETON OCEAN MODEL

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LONG-TERM GOALS

Contribute to the development of the components of limited area, open-boundary, coastal nowcast/forecast systems which will resolve the time and scales of the relevant ocean dynamics in shallow coastal environments.

OBJECTIVES

TASK 1. Improvement of the data assimilation capability of the NRL Layered Ocean Model (NLOM) in the framework of the Data Assimilation and Rapid Transition system of NRL;
TASK 2. Development of technology for coupling NLOM with the Pacific West Coast Princeton Model (PWC) (Metzger et. al., 1997).

APPROACH

TASK 1. The projection of surface information (satellite altimeter sea surface height data (SSH)) into subsurface fields is divided into two steps (Shulman and Smedstad, 1998; ONR, Fiscal Year 1997 Annual Reports): the first guess of the nudging terms is obtained by the statistical inference technique; then, a simple variational problem is used to correct these terms in accordance with the current model dynamics.
TASK 2. Under the grant N00014-95-1-0258, the methods and technology had been developed for coupling basin scale and limited area coastal models (Shulman and Lewis 1995, 1996). This technology have been extended and applied to couple the NRL layer model with the Pacific West Coast model. This research have been performed in close collaboration with Dr. O. M. Smedstad, Planning Systems, Inc.; Research on TASK 2 has been performed in collaboration with Dr. D.S. Ko, Sverdrup Technology Inc., Dr. J. K.

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Lewis, Ocean Physics Research & Development, and Mr. J.G. Mayer, Ph.D student of USM. Also, this research has been conducted in coordination and collaboration with the NRL scientists: Drs. Hurlburt, Wallcraft, Kindle and Mr. Rhodes.

WORK COMPLETED

TASK 1

Data assimilation experiments (identical twin experiments) were conducted with the reduced gravity and finite depth versions of a $1/8^\circ$ the Sea of Japan version of the NLOM.

Numerical experiments with assimilation of real Topex/Poseidon data into $1/4^\circ$ global version of NLOM and $1/16^\circ$ Pacific version of the NLOM have been conducted in order to determine optimal values of data assimilatiom parameters for these models.

TASK 2

Runs of the PWC model coupled to the 6-layer finite depth, altimeter SSH data assimilating, NRL global model has been conducted for the period from 12/31/93 to 12/30/97.

Experiments with the different specification of open boundary conditions for the PWC model have been conducted.

A new scheme of coupling has been found which improved significantly the predictive skill of PWC model.

RESULTS

TASK 1. The identical twin experiments with the $1/8^\circ$ 4-layer finite depth Sea of Japan version of the NLOM show that the proposed approach results in a significant improvement in the prediction of SSH and layer pressures (especially for the top layers) (Shulman and Smedstad, 1998). The numerical experiments with assimilation of real Topex/Poseidon data into $1/4^\circ$ global version of NLOM and $1/16^\circ$ Pacific version of the NLOM show that the results of the simulations are very sensitive to the inversion of the statistically inferred subsurface pressures corrections into the corresponding correction to the layer thicknesses. This inversion is achieved by using singular value decomposition of the linear matrix representing the relations between pressure and layer thickness. In (Shulman and Smedstad, 1998), we developed an approach to determine the optimal value of μ for each subdomain of the model domain. The optimal values of data assimilation parameters were determined for twelve subdomains of the global model (two subdomains in Indian ocean, four sudomains in Pacific ocean, four subdo-

mains in Atlantic ocean, all area below 40S of latitude and Gulf of Mexico area). Also, the assimilation of Topex/Poseidon SSH data into the 1/4° global version of NLOM show that there should be some optimal decomposition of the global model domain into a subset of subdomains, where the parameters of the data assimilation scheme are the same within each subdomain. The reseach on this topic is under way.

TASK 2

It has been found that significant improvements in prediction in the southern portion of PWC result when a Flather formulation is used for the barotropic boundary conditions instead of the existing operational scheme. The results of simulations for the period of 1/31/95 - 6/28/95 are presented on http://www.coam.usm.edu/shulman/PWCRESULTS. With the use of the new scheme one can see that the flow is more energetic, there is a strong presence of the Southern California Countercurrent during the winter months, and a strong southward flow in April. The linear correlation coefficients between PWC and tide gauge data are shown in Table 1.

Table 1

The linear correlation coefficients of daily sea level variations between PWC and tide gauge data for old and new schemes

Tide Station	Time					
	6/29/94-6/28/95		6/29/94-6/27/96		6/29/94-6/28/97	
	new	old	new	old	new	old
Neah Bay, WA	0.92	0.86	0.89	0.86	0.87	0.85
Crescent City, CA	0.89	0.85	0.86	0.75	0.84	0.75
San Francisco, CA	0.82	0.71	0.74	0.52	0.71	0.55
San Diego, CA	0.75	0.09	0.73	0.17	0.68	0.14

Fig. 1 compares the observed and model sea level variations for San Diego station. One can see that the curve predicted with the use of the new scheme follow the observed curve better (there is an evident annual cycle in the sea surface elevation variations).

IMPACT/APPLICATIONS

This project is a contribution (TASK 1) to the improvement of the data assimilation capability of the NRL oceanic prediction system.

The development of technology for coupling the NLOM with the regional models like PWC (TASK 2) enhances the Navy's capabilities in the development of coastal nowcast/forecast models.

TRANSITIONS

Developed techniques and software have being incorporated into the latest version of the NRL data assimilation system.
The code of PWC model with the new coupling scheme is made available to the community by acccesing web site.

RELATED PROJECTS

6.2 Basin Scale Ocean Prediction System of NRL (NOMP, ONR).
Global Ocean Prediction System of NRL (NOMP, ONR).
"An Innovative Coastal-Ocean Observing Network (ICON)" , National Oceanographic Partnership Program (NOPP).

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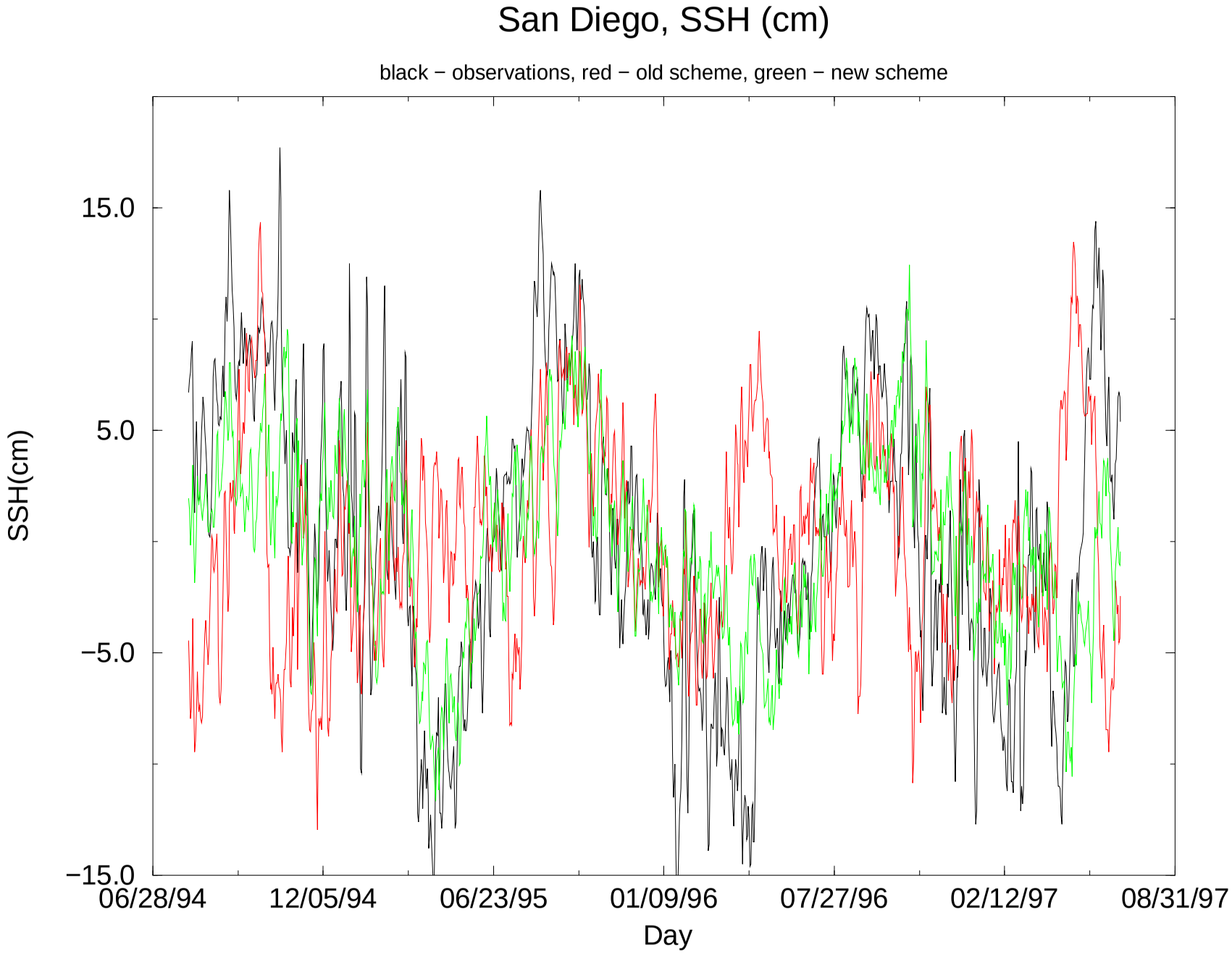
San Diego, SSH (cm)
black − observations, red − old scheme, green − new scheme
SSH(cm)
15.0
5.0
−5.0
−15.0
06/28/94
12/05/94
06/23/95
01/09/96
07/27/96
02/12/97
08/31/97
Day